Claims

[c1] 1.An electropolishing solution, comprising:
about 75 to about 99 weight percent of an alkylene glycol; and
about 1 to about 25 weight percent of a chloride salt selected from the group consisting of alkali metal chlorides, alkaline earth metal chlorides, and combinations thereof.

[c2] 2.The electropolishing solution of Claim 1, wherein the alkylene glycol is selected from the group consisting of ethylene glycol, 1,2-propylene glycol, 1,3-propylene glycol, glycerol, 1,3-butylene glycol, 1,4-butylene glycol, 2,3-butylene glycol, 1,5-pentanediol, 1,6-hexanediol, 1,8-octanediol, 1,9-nonanediol, 1,10-decanediol, neopentyl glycol, 1,4-cyclohexanedimethanol, 2-methyl-1,3-propanediol, 2,2,4-trimethyl-1,3-pentanediol, diethylene glycol, dipropylene glycol, triethylene glycol, tripropylene glycol, dibutylene glycol, polyethylene glycol, polypropylene glycol, polytetramethylene glycol, and combinations thereof.

[c3] 3.The electropolishing solution of Claim 1, wherein the alkylene glycol comprises ethylene glycol or propylene glycol.

[c4] 4.The electropolishing solution of Claim 1, wherein the chloride salt is selected from the group consisting of lithium chloride, sodium chloride, potassium chloride, magnesium chloride, calcium chloride, and combinations thereof.

[c5] 5.The electropolishing solution of Claim 1, wherein the chloride salt comprises potassium chloride.

[c6] 6.The electropolishing solution of Claim 1, comprising less than or equal to 5 weight percent water.

[c7] 7.The electropolishing solution of Claim 1, comprising less than 0.5 weight percent fluoride ion.

[c8] 8.An electropolishing solution, comprising:
about 75 to about 99 weight percent of ethylene glycol; and
about 1 to about 25 weight percent of potassium chloride.

[c9] 9.An electropolishing solution, consisting essentially of:
about 75 to about 99 weight percent of ethylene glycol; and
about 1 to about 25 weight percent of potassium chloride.

[c10] 10.An electropolishing method, comprising:
disposing a metallic substrate and at least one electrode in an electrolyte solution; wherein the electrolyte solution comprises
about 75 to about 99 weight percent of an alkylene glycol; and
about 1 to about 25 weight percent of a chloride salt selected from the group consisting of alkali metal chlorides, alkaline earth metal chlorides, and combinations thereof; and
applying a current from a power source between the at least one electrode and the metallic substrate to remove metal from the metallic substrate.

[c11] 11.The electropolishing method of Claim 10, wherein the current is applied at a voltage of about 3 to about 100 volts.

[c12] 12.The electropolishing method of Claim 10, wherein the current is applied at a current density of about 0.1 to about 20 amperes per square-centimeter.

[c13] 13.The electropolishing method of Claim 10, wherein the electrolyte solution has a temperature of about 50 to about 200 ° C.

[c14] 14.The electropolishing method of Claim 10, wherein metal is removed from the metallic substrate at a rate of about 1 to 200 micrometers per minute.

[c15] 15.A method of recovering an electropolishing solution, comprising:
agitating a spent electropolishing solution comprising
an alkylene glycol,
a chloride salt, and
a metal-containing solid; and
separating the agitated, spent electropolishing solution to yield the metal-containing solid and a solid-depleted solution.

[c16] 16.The method of Claim 15, wherein the spent electropolishing solution comprises about 75 to about 98 weight percent of the alkylene glycol.

[c17] 17.The method of Claim 15, wherein the spent electropolishing solution comprises about 2 to about 25 weight percent of the chloride salt.

[c18] 18.The method of Claim 15, wherein the metal-containing solid comprises a metal selected from the group consisting of aluminum, titanium, vanadium, chromium, manganese, iron, cobalt, nickel, copper, niobium, molybdenum, silver, halfnium, tungsten, platinum, gold, and combinations thereof.

[c19] 19.The method of Claim 15, wherein the metal-containing solid comprises titanium.

[c20] 20.The method of Claim 15, wherein the metal-containing solid comprises about 10 to about 25 weight percent titanium, about 5 to about 20 weight percent carbon, and about 1 to about 5 weight percent hydrogen, on a dry weight basis.

[c21] 21.The method of Claim 15, wherein the metal-containing solid has an average particle size of less than 20 micrometers prior to agitating.

[c22] 22.The method of Claim 15, wherein agitating the spent electropolishing solution is conducted at a temperature greater than 100 ° C.

[c23] 23.The method of Claim 15, wherein agitating comprises an input of about 10,000 to about 1,000,000 joules per kilogram of spent electropolishing solution.

[c24] 24.The method of Claim 15, wherein agitating comprises sparging with a pressurized gas having a pressure of about 0.01 kg/cm^2 to about 1000 kg/cm^2.

[c25] 25.The method of Claim 24, wherein the pressurized gas comprises air.

[c26] 26.The method of Claim 24, further comprising adding water to the spent electropolishing solution in an amount of about 0.001 to about 5 weight percent based upon the total weight of the spent electropolishing solution.

[c27] 27.The method of Claim 24, wherein the pressurized gas comprises a water concentration effective to create a water concentration of about 0.001 to about

5 weight percent water in the spent electropolishing solution during agitation.

[c28] 28.The method of Claim 15, wherein the metal-containing solid has an average particle size greater than 20 microns after agitating.

[c29] 29.The method of Claim 15, further comprising distilling the solid-depleted solution.

[c30] 30.A method of recovering an electropolishing solution, comprising:
sparging a spent electropolishing solution with pressurized air, wherein the spent electropolishing solution comprises
about 75 to about 98 weight percent of ethylene glycol,
about 2 to about 25 weight percent of potassium chloride, and
at least 1 weight percent of a titanium-containing solid comprising about 10 to about 25 weight percent titanium, about 5 to about 20 weight percent carbon, and about 1 to about 5 weight percent hydrogen, on a dry weight basis; and
separating the sparged, spent electropolishing solution to yield the titanium-containing solid and a solid-depleted solution.